Assignment for SP226 Due 04/12/00 Name _____
Chapter 33

1* • Why is helium needed in a helium–neon laser? Why not just use neon?

2 •• When a beam of visible white light passes through a gas of atomic hydrogen and is viewed with a spectroscope, dark lines are observed at the wavelengths of the emission series. The atoms that participate in the resonance absorption then emit this same wavelength light as they return to the ground state. Explain why the observed spectrum nevertheless exhibits pronounced dark lines.

3 • A pulse from a ruby laser has an average power of 10 MW and lasts 1.5 ns. (*a*) What is the total energy of the pulse? (*b*) How many photons are emitted in this pulse?

8 •• Singly ionized helium is a hydrogen-like atom with a nuclear charge of 2*e*. Its energy levels are given by $E_n = -4E_0/n^2$, where $E_0 = 13.6$ eV. If a beam of visible white light is sent through a gas of singly ionized helium, at what wavelengths will dark lines be found in the spectrum of the transmitted radiation?

12 • On a spacecraft sent to Mars to take pictures, the camera is triggered by radio waves, which like all electromagnetic waves travel with the speed of light. What is the time delay between sending the signal from the earth and receiving it on Mars? (Take the distance to Mars to be 9.7×10^{10} m.)

14 •• In Galileo's attempt to determine the speed of light, he and his assistant were located on hilltops about 3 km apart. Galileo flashed a light and received a return flash from his assistant. (*a*) If his assistant had an instant reaction, what time difference would Galileo need to be able to measure for this method to be successful? (*b*) How does this time compare with the human reaction time, which is about 0.2 s?

15 • How does a thin layer of water on the road affect the light you see reflected off the road from your own headlights? How does it affect the light you see reflected from the headlights of an oncoming car?

16 • A ray of light passes from air into water, striking the surface of the water with an angle of incidence of 45°. Which of the following four quantities change as the light enters the water: (1) wavelength, (2) frequency, (3) speed of propagation, (4) direction of propagation. (*a*) 1 and 2 only (*b*) 2, 3, and 4 only (*c*) 1, 3, and 4 only (*d*) 3 and 4 only (*e*) 1, 2, 3, and 4

17*•• The density of the atmosphere decreases with height, as does the index of refraction. Explain how one can see the sun after it has set. Why does the setting sun appear flattened?

62 • True or false:
(*a*) Light and radio waves travel with the same speed through a vacuum.
(*b*) Most of the light incident normally on an air–glass interface is reflected.
(*c*) The angle of refraction of light is always less than the angle of incidence.
(*d*) The index of refraction of water is the same for all wavelengths in the visible spectrum.
(*e*) Longitudinal waves cannot be polarized.

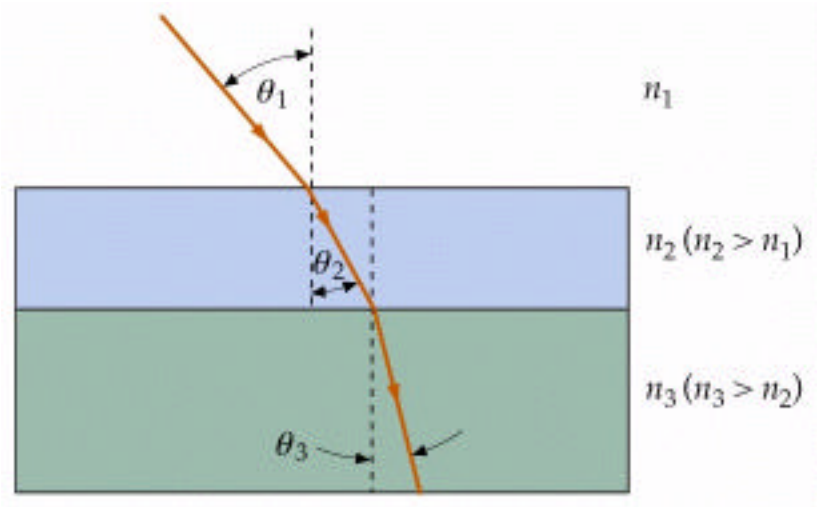
64 •• It is a common experience that on a calm, sunny day one can hear voices of persons in a boat over great distances. Explain this phenomenon, keeping in mind that sound is reflected from the surface of the water and that the temperature of the air just above the water's surface is usually less than that at a height of 10 or 20 m above the water.

19 • Find the angle of refraction of a beam of light in air that hits a water surface at an angle of incidence of (*a*) 20°, (*b*) 30°, (*c*) 45°, and (*d*) 60°. Show these rays on a diagram.

20 • Calculate the fraction of light energy reflected from a beam of light initially in water that is incident on a water–air interface at normal incidence.

25* •• Light is incident normally on a slab of glass with an index of refraction $n = 1.5$. Reflection occurs at both surfaces of the slab. About what percentage of the incident light energy is transmitted by the slab?

28 •• In Figure 33-51, light is initially in a medium (such as air) of index of refraction n_1. It is incident at angle θ_1 on the surface of a liquid (such as water) of index of refraction n_2. The light passes through the layer of water and enters glass of index of refraction n_3. If θ_3 is the angle of refraction in the glass, show that $n_1 \sin\theta_1 = n_3 \sin\theta_3$. That is, show that the second medium can be neglected when finding the angle of refraction in the third medium.



45*• Two polarizers have their transmission axes at an angle θ. Unpolarized light of intensity I is incident upon the first polarizer. What is the intensity of the light transmitted by the second polarizer? (*a*) $I\cos^2\theta$ (*b*) $(I\cos^2\theta)/2$ (*c*) $(I\cos^2\theta)/4$ (*d*) $I\cos\theta$ (*e*) $(I\cos\theta)/4$ (*f*) None of the above.

46 • Which of the following is *not* a phenomenon whereby polarized light can be produced from unpolarized light? (*a*) absorption (*b*) reflection (*c*) birefringence (*d*) diffraction (*e*) scattering

47 • What is the polarizing angle for (*a*) water with $n = 1.33$ and (*b*) glass with $n = 1.5$?

50 •• The polarizing angle for a certain substance is 60°. (*a*) What is the angle of refraction of light incident at this angle? (*b*) What is the index of refraction of this substance?

52 •• Two polarizing sheets have their transmission axes crossed so no light gets through. A third sheet is inserted between them. If the middle polarizing sheet is rotating at an angular velocity ω about an axis parallel to the light beam, find the intensity transmitted through all three sheets as a function of time. Assume that $\omega = 0$ at time $t = 0$.

67 •• The critical angle for total internal reflection for a substance is 45°. What is the polarizing angle for this substance?